1996-03

Implementation consideration for Windows NT integrated network for System Management computer laboratories

Arum, Mochamad

Monterey, California. Naval Postgraduate School

NAVAL POSTGRADUATE SCHOOL
MONTEREY, CALIFORNIA

THESIS

IMPLEMENTATION CONSIDERATION FOR WINDOWS NT INTEGRATED NETWORK FOR SYSTEM MANAGEMENT COMPUTER LABORATORIES

by

Mochamad Arum

March, 1996

Principal Advisor:	Norman F. Schneidewind
Associate Advisor:	Rex A. Buddenberg

Approved for public release; distribution is unlimited.

REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	March 1996	Master's Thesis

4. TITLE AND SUBTITLE IMPLEMENTATION CONSIDERATION FOR WINDOWS NT INTEGRATED NETWORK FOR SYSTEM MANAGEMENT COMPUTER LABORATORIES	5. FUNDING NUMBERS
6. AUTHOR(S) Mochamad Arum	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey, CA 93943-5000	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.

12a. DISTRIBUTION/AVAILABILITY STATEMENT	12b. DISTRIBUTION CODE
Approved for public release; distribution is unlimited.	

13. ABSTRACT *(maximum 200 words)*

The integrated token ring LAN of the System Management Department of the Naval Postgraduate School is progressively moving its network platform from Microsoft Windows for Workgroups to Windows 95 Client and Windows NT Server to improve LAN performance and to meet an increasing demand from students and the faculty for the latest software applications

This thesis is a study of configuration for the installation of Windows NT Server 3.51 and the incremental testing of clients to access applications on the server from Windows for Workgroups and Windows 95 Clients. The research includes a review of the installation of Windows for Workgroups, and Windows 95 and installation of the Windows NT Servers.

The recommendations presented include suggestions for the upgrade of the System Management Department LAN to Windows NT Servers with Windows 95 Clients.

14. SUBJECT TERMS Client-Server; Windows NT 3.51 Server; Token Ring Network; Installation and Testing Software; Windows for Workgroups; Windows 95	15. NUMBER OF PAGES 51
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	UL

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18 298-102

Approved for public release; distribution is unlimited.

IMPLEMENTATION CONSIDERATION FOR WINDOWS NT INTEGRATED NETWORK FOR SYSTEM MANAGEMENT COMPUTER LABORATORIES

Mochamad Arum, Commander, Republic Indonesia
B.S., The Indonesian Naval Education of Science and Technology - 1986

Submitted in partial fulfillment
of the requirements for the degree of

MASTER OF SCIENCE
IN
INFORMATION TECHNOLOGY MANAGEMENT

from the

NAVAL POSTGRADUATE SCHOOL
March 1996

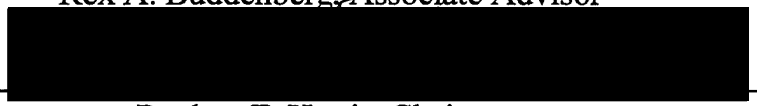
Author: 

Mochamad Arum

Approved by: 

Norman F. Schneidewind, Principal Advisor

Rex A. Buddenberg, Associate Advisor



Reuben T. Harris, Chairman
Department of System Management

ABSTRACT

The integrated token ring LAN of the System Management Department of the Naval Postgraduate School is progressively moving its network platform from Microsoft Windows for Workgroups to Windows 95 Client and Windows NT Server to improve LAN performance and to meet an increasing demand from students and the faculty for the latest software applications.

This thesis is a study of configuration for the installation of Windows NT Server 3.51 and the incremental testing of clients to access applications on the server from Windows for Workgroups and Windows 95 Clients. The research includes a review of the installation of Windows for Workgroups, and Windows 95 and installation of the Windows NT Servers.

The recommendations presented include suggestions for the upgrade of the System Management Department LAN to Windows NT Servers with Windows 95 Clients.

TABLE OF CONTENTS

I. INTRODUCTION 1

A. OBJECTIVES 1

B. RESEARCH QUESTIONS 2

C. SCOPE AND METHODOLOGY 2

1. Literature Review 2

2. Research Technique 2

3. Interviews and Discussions 3

D. ORGANIZATION OF THESIS 3

II. BACKGROUND 5

A. THE SYSTEM MANAGEMENT COMPUTER LABORATORIES 5

1. Types of Resources. 6

2. Major Network Components 6

3. Human Resources 7

B. WINDOWS NT SERVER 3.51 8

1. Features of Windows NT Server 3.51 8

2. Client/Server Model 9

3. Multiprocessing 10

4. Security 11

5. Integrated Networking and Messaging Facilities 12

C. CHAPTER SUMMARY 13

III. SETTING UP WINDOWS NT SERVER - A PROTOTYPE 15

A. INSTALLATION PLANNING 15

1. File Systems 15

2. Domains and Workgroups 17

B. INSTALLATION OF WINDOWS NT SERVER 19

C. TESTING 21

D. FUTURE APPLICATION INSTALLATION 23

E. CHAPTER SUMMARY 23

IV. SETTING UP CLIENT TO ACCESS NT SERVER - A PROTOTYPE 25

A. INCREMENTAL INSTALLATION AND TESTING PROCEDURES 25

B. RUNNING APPLICATIONS UNDER WINDOWS FOR WORKGROUPS 26

C. RUNNING APPLICATION UNDER WINDOWS 95 29

D. FUTURE UPGRADES 30

E. CHAPTER SUMMARY 31

V. CONCLUSIONS AND RECOMMENDATIONS 33

A. REVIEW OF RESEARCH QUESTIONS 33

1. Research Question 1 33

2. Research Question 2 33

3. Research Question 3 34

B. RECOMMENDATIONS 35

LIST OF REFERENCES 37

INITIAL DISTRIBUTION LIST 39

LIST OF TABLES

1. Access Times for 1, 6 and 9 Pentium 90 MHz 28

I. INTRODUCTION

Computer hardware and software continue to evolve rapidly, providing more substantially profitable information technology and its application year after year. Connectivity is proliferating at a very high rate and its cost is decreasing. The diffusion of information technology can and must be managed. If it is poorly managed, information technology will evolve not into a well-functioning and useful system but, instead, into a collection of disjointed islands of computer technology that pass data between each other only with great difficulty.

The networking Windows NT environment which is properly designed on the distributed computing model, ensure a reliable system, secure and easy to use and scaleable to accommodate the grow of an organization. Windows NT is engineered to support every popular client operating systems, such as MS-DOS, Windows, OS/2, and Macintosh. Windows NT will also integrates with Netware, LAN Manager, UNIX, SNA, and others.

This thesis provides a study of Windows NT Server 3.51 and how it will fit into the integrated network for System Management (SM) computer laboratories at The Naval Postgraduate School. The concept of implementing Windows NT networking will gradually standardize the various types of operating systems in all departments at the Naval Postgraduate School in the future.

A. OBJECTIVES

The purpose of this research is to determine one common configuration and method for setting-up the Windows NT server and the client computer as it relates to the effort of moving from the current Windows for Workgroups (WFWG) network operating system environment to Windows NT network operating system environment. Configurations for WFWG and Windows 95 will be considered.

B. RESEARCH QUESTIONS

The objective of this thesis is to outline an implementation of a Windows NT Server 3.51 using the token ring integrated network of the SM Department. This thesis will answer three research questions related to this issue:

- What is the current networking system of the SM computer laboratories?
- What is the Windows NT Server 3.51? This will include the characteristics, the advantages and the disadvantages of this operating system. Also to be considered are possible features of Windows NT to be implemented on the current network.
- How would the installation of the Windows NT Server 3.51 help the SM labs? This will include setting-up the server, the client systems and their application on an integration network. Also to answer this question it is necessary to address the idea of server centralization.

C. SCOPE AND METHODOLOGY

The scope of this thesis is to study the possibility of upgrading the server capability in SM labs I-250, I-224, and I-158 by installing Windows NT server 3.51 network operating system on Pentium 90 MHz computers and giving appropriate clients access to this server through the network. The methodology to achieve this goal will include:

1. Literature Review

Conduct a literature review of Window NT Resource Kit, Networking Windows NT Server 3.51 and other current networking books dealing with the features of Windows NT. Also conduct an overview of the previous studies in the area of Local Area Network (LAN), involving Microsoft WFWG, Windows 95, and the token ring protocol.

2. Research Technique

Hands on work in the labs; implementation of Windows NT Server 3.51 on the Pentium 90 MHz computers and several other PCs running application software.

3. Interviews and Discussions

Conduct direct and indirect interview and discussions (meeting, telephone, and E-mail) with thesis advisor, professionals, and networking experts to obtain knowledge of the Windows NT networking environment. The discussion will also include performance results as well as network management issues.

D. ORGANIZATION OF THESIS

This thesis is organized in five chapters:

- Chapter I, "Introduction", presents the purpose of this thesis and general information concerning the capability of the Windows NT network environment.
- Chapter II, "Background", presents the current configuration of the SM LAN. It will also give a general description of Windows NT Server 3.51.
- Chapter III, "Setting Up Windows NT Server" presents installation of Windows NT Server 3.51 as a prototype and its implementation on the integrated token ring network in the SM labs. It will also discuss the performance testing of the Windows Server 3.51 as a server for clients on the network. It also proposes future upgrades for the server to increase SM LAN performance.
- Chapter IV, "Setting Up Client to access Windows NT Server" provides a prototype of the clients running under WFWG and Windows 95. It will also propose future upgrades for both hardware and software to anticipate the future needs of the end-user. This upgrading of the system will give users greater access to Windows NT Server 3.51 network environment.
- Chapter V, "Conclusion and Recommendations" provides answers to the research questions and recommendations for further research.

II. BACKGROUND

There are various network technologies used in the SM laboratories, such as Ethernet, AppleTalk, and token ring. The capabilities of the token ring, however, make it the best choice for an anticipated increase of users. Dealing with an increased demand for hardware and software resources, starting in 1994, the SM laboratories integrated the token rings in I-224 (referred to as 4TR), I-250 (referred to as 0TR), and I-158 (referred to as 8TR) into a single system. At the end of Fall 1995, the three token ring LANs had been successfully integrated into a single network.

In order to achieve software improvements for the anticipated increase in demand from students and faculty for the latest software applications and to increase LAN performance, the lab staff decided to add a new capability by installing Windows NT Server 3.51 on the integrated token ring LAN. This chapter will examine what comprises a token ring and a dedicated server for an integrated token ring LAN.

A. THE SYSTEM MANAGEMENT COMPUTER LABORATORIES

The new configuration of the integrated token ring LAN of the SM laboratories is clearly based on the earlier ring type networks and is a baseband LAN with a star ring topology and speed of 16 Mbps. Each client is connected, through a token ring network interface card, by a "loop" of data grade cable (shielded twisted pair), to a number of Multistation Access Units to form a single larger physical ring that runs through rooms I-250, I-224 and I-158 in the Ingersol building. The logical integration of this network is accomplished through software. [Ref.1] Appendix G provides an integrated LAN diagram, compiled thorough descriptions of this latest network configuration. The diagram consists of the equipment, connections (physically and logically) and their configuration across the building.

The following is a review of the integrated TR LAN resources necessary for understanding later discussions in this study.

1. Types of Resources

- User computers and Instructor computers (486 DX 33 MHz)
- Server computer (Pentium 90 MHz)
- Multistation Access Units (MAUs)
- Printers (HP LaserJet III and HP DeskJet 500)
- Modems (2400 baud in IN-224; 9600 baud in IN-250)
- CD-ROM (on TN36 in IN-224; N10 in IN-250; PN9 in IN-158
- Graphics scanner (on TN25 in IN-224)
- Software: DOS, Window for Workgroups , and application programs
- Uninterruptible power supplies (UPS)

2. Major Network Components

a. Multistation Access Unit

- Used for token ring LAN
- Centralized connections for reliability, ease of connection and disconnection
- Used to form a physical star, logical ring network configuration
- Each MAU has 8 ports with a Ring In (RI) and Ring Out (RO) port for adding MAU's

b. Network Interface Card (NIC):

- It is installed in all user computers and server computers
- For interface from computers to the network
- Handles token recognition, token generation, address recognition, error checking and logging, time out control and link fault detection

c. Router:

- Token Ring LAN is connected to a Router in the Computer Center
- Function: To route packets outside I-224 and I-250 and between token ring LAN and Ethernet LAN

d. Wiring:

- Type 1 Shielded Twisted Pair (STP - IBM Data Grade)
- Cabling physically connected in star arrangement to MAUs
- Wiring installed to physically connect I-224, I-250, and I-158.

3. Human Resources

Management of the networks and network administration in the SM labs is performed by two full-time network specialists under the supervision of one professor as Lab Director. The tasks can be categorized as follows: [Ref. 2]

- Major network upgrades, both hardware and software
- Maintenance (i.e., maintaining software and hardware)
- Documentation (i.e., backups and archiving information)
- Consulting (i.e., answering questions from users and solving problems)
- Network planning

To maximize network functionality and end-user satisfaction, especially to support wide variety of curricula, it is very challenging and time-consuming for the network specialist. There are several ways to decrease network specialist's workload. One way is to install Window NT Server 3.51. The following section provides a general description of the Windows NT Server 3.51.

B. WINDOWS NT SERVER 3.51

Closely tied to the requirements of the user, the SM Department Network Plans and the SM LAN Administration Goals recommend an upgrade of the Network Operating System (NOS) to a modern NOS [Ref. 1]. The Windows NT Operating System will provide the users, especially the ITM students, with exposure to a modern NOS that is commonly used by DOD and the private sector.

1. Features of Windows NT Server 3.51

This section will explore a few key features of the new NOS proposal.

a. Hardware Independence

Windows NT Server is a comprehensive server operating system which is capable of being run on Intel, Pentium microprocessor base PCs and other hardware platforms such as MIPS R4000 RISC (Reduced Instruction Set Computer), Digital's Alpha AXP and the Motorola power PC 60X. A variety of hardware platforms can be chosen from those that best suited the users' needs while maintaining the application compatibility across platforms. Windows NT Server allows the users to share information and access printers and other devices across the network.

b. 32-Bit Operating System

Windows NT uses a 32-bit operating system. It moves data in 32 bit chunks. The 32-bit capability makes operations faster and more efficient than one optimized for 16 bits, such as running is the case of the WFWG operating system. Since Windows NT supports 32-bit addresses, it will allow more memory to be used to support ever larger programs.

c. Virtual 32-bits Linear Address Space

A process, a task that is running in Windows NT, can address a virtual linear address space of 2^{32} or 4 Giga bytes. A virtual memory address is a way to use more memory than it is actually available. Memory is divided into pages. Virtual memory made up of pages that are swapped into and out of a swap space on hard disk. This creates

the illusion for a program or memory mapped file of having a much larger memory size. The swapping of pages into and out of memory is handled by Windows NT and the CPU. The operating system ensures that the individual processes do not interfere with one another. Additionally, the virtual memory system of Windows NT allows programs to share program code that is in common with other programs by mapping their address space. Other efficiencies are gained by not swapping program code to the hard disk because it can be reloaded from the program and any secure system does not allow program code to be self-modifying.

d. Windows NT Architecture

The Windows NT is comprised of a small microkernel operating system surrounded by a few protected subsystems. This prevents one subsystem from destroying data that belongs to another. These subsystems do not share memory and each of them has a different environment. The microkernel-mode which is called the Windows NT Executive is responsible for a lot of tasks: scheduling activities, resources management, memory and input/output device access. Windows NT allows users to execute several types of application programs such as: Windows 16-bit application, OS/2 character mode application, POSIX application, DOS application, WFWG and Windows NT 32-bit applications. The way the operating system interacts makes it easy to add a new subsystem without affecting existing subsystems. The lowest level parts of the Windows NT Executive are the kernel and the hardware abstraction layer (HAL). The Windows NT-kernel performs a low-level operating system function and the HAL directly manipulates the hardware. With its microkernel architecture, Windows NT Server 3.51 will be ready for the hardware and software advances in years to come, and is protected from obsolescence.

2. Client/Server Model

Windows NT uses a client-server model to provide multiple operating system environments (Windows 3.x, WFWG, WINDOWS 95, MS-DOS, OS/2) and it uses an object model to uniformly manage the operating system resources and dispense them to

users. Each server runs in a user mode, executing a loop that checks whether a client has requested one of its services. The client, which can be either another operating system component or an application program, requests information or a service by sending a message to the server. The microkernel, running in the server kernel mode, delivers the message to the server; the server performs the operation; and the kernel returns the results to the client in another message. Since the client never has an access directly to the data or services, it is therefore incapable of corrupting global data inadvertently. This client/server model lends itself well to distributed computing. The clients and servers do not have to run on the same machine. The client can have requests serviced locally or by a remote server through the network.

3. Multiprocessing

Multiprocessors are computers with more than one CPU with a common memory and other resources. In order to take advantage of a multiprocessor, the operating system must support multiple threads of execution. This will allow the computer to run one thread on one CPU and other thread on others, thereby achieving parallel execution of a program. This multiprocessing technology gives Windows NT a powerful hardware scaleability for application programs that are written to take advantage of more than one processor. However, currently there are few PC application programs, that are written to take advantage of this capability. Recently, with the release of Windows 95, this situation has changed. The Windows 95 Office Suite made up of Word, Excel and other office programs is multi-threaded. The operating system can take advantage of this capability. A large portion of the operating system code for Windows NT is able to run on more than one processor.

A multi-threaded operating system should be differentiated from a time shared system. In a time shared system, processor time is shared between the various user programs. An example of this type of system is the current commercial UNIX operating system. In a multi-threaded operating system, a program may have more than a single path of operation and these are time shared in the operating system. The key difference

between these two types of time shared operation is that the UNIX-like system has provisions for only one processor and the NT multi-threaded system may allow more than one processor to run threads on the same program. Thereby, achieving the parallel operation of the program. Of note is that OS/2 is a multi-threaded operating system but not a multiprocessing system.

There are two types of multiprocessing system:

a. Asymmetric Multiprocessing (ASMP)

An ASMP multiprocessor would have, for instance, only the operating system to run on one particular processor, and other processors would act like coprocessors. Each processor has a different, specifically defined job. ASMP operating systems are well suited to running on asymmetric hardware, such as a processor with an attached coprocessor or two processors that do not share all available memories. However, this arrangement is not portable across different hardware platforms.

b. Symmetric Multiprocessing (SMP)

SMP systems, including Windows NT, has both applications and the operating system executed over several processors simultaneously, sharing memories among them. This approach, that Windows NT uses the power of multiple processors, because the operating system itself can use a significant percentage of a computer's processing time. In the case of a load balancing system, SMP can reduce downtime when one of the processors fails, because the operating system code can automatically execute on other processors. Windows NT can run on computers with 1 to 32 processors [Ref. 3].

4. Security

Windows NT allows system administrators to establish a full range of level security, from no security to C2 level of security. It incorporates several features that implement security:

- A new file system called NTFS (NT File System), with definable access control

- Access control for all resources
- User passwords for log on
- A special account for each computer, called an Administrator account with special privileges for maintenance of a Windows NT computer and its resources.

The security model includes components to control those who access an object (such as files and shared printers), which actions an individual can take on an object, and which events are audited. Each resource object has a small database attached to it, called an Access Control List (ACL), specifying which processors are allowed to access the object and with what operations they may perform.

5. Integrated Networking and Messaging Facilities

Windows NT has the following integrated networking and messaging facilities:

- Windows NT supports both peer to peer networking and client/server networking. Files and resources (like printers) can be shared across a network. User can also use other machines that are present on a network. In addition to using resources on a certain computer, it is possible to use applications on other computers on the network. This capability may be used like client/server model, or it may be a specialized like application distributed computing. Windows NT Servers also includes features needed for full-scale servers, such as domain management tools.
- Built-in networking software allows protocol drivers, network card drivers, and other network software to be added to Window NT. Windows NT include four transport protocols :
    - IPX/SPX, Netware: Internet Packet Exchange/Sequenced Packet Exchange.
    - TCP/IP (Transmission Control Protocol/Internet Protocol)
    - NBF (Net BEUI FRAME)
    - DLC, Windows NT: Data Link Control to communicate with IBM-SNA

By using this capability, a Windows NT computer can simultaneously communicate with a number of different network systems [Ref. 4].

- Interoperability with existing networks through a variety of transport protocol and network adapters. Windows NT is also compatible with other computer networks like Novell Netware and Banyan Vines. Users can run applications in Windows NT that utilize these other types of networks, and at the same time have other applications running that use Windows NT's own networking system. Windows NT comes with a mail application that permits communication with other Windows NT machines in an installation. This application uses the Mail Program facilities to communicate to members of a group.

C. CHAPTER SUMMARY

Windows NT as it advertise is a network ready, secure, and scaleable operating system that may run many different operating system environments simultaneously, including: DOS, OS/2 3.x, Windows 16-bit and Windows NT 32-bit.

Windows NT supports multiple threads of execution on multiple processes. That is, the user can perform several tasks at the same time on computer, if the application is written to take advantage of this capability. Applications can take advantage of multiprocessor support, by executing different threads on different processors. Windows NT supports symmetric multiprocessing; the operating system is written to take advantage of the presence of multiple processors if the PC has multiple processors, just as applications can. For corporate enterprise-wide computing, or for small peer-to-peer networks, Windows NT offers users the Windows interface, plus the benefits of a sophisticated and secure as C-2 level security operating system. The following chapter will outline the proposed installation of Windows NT 3.51 as a server in the integrated token ring network in the SM laboratories.

III. SETTING UP WINDOWS NT SERVER - A PROTOTYPE

Windows NT Server 3.51 is a large and complex operating system. It requires a good deal of planning to successfully install Window NT Server 3.51 on a Pentium 90 MHz computer. There are several important decisions to be made during the installation process, such as:

- which file system to be used and
- what type of domain server is to be chosen.

The hardware requirements for a computer to run Windows NT are at least a 386-based PC 25 MHz or higher, with 12 MB of RAM [Ref. 5]. The capability of Pentium 90 MHz with 40 MB RAM are more than enough to meet this requirement.

The lab staff has installed the Pentium 90 MHz computer as a Windows NT 3.51 Server [Ref. 6]. It has been designed as a File Allocation Table system to provide compatibility with DOS applications for the users on the integrated token ring network of the SM computer labs. In addition to the above issues, security issues is also addressed.

A. INSTALLATION PLANNING

This subsection will discuss several important kinds of information required for making decisions during installation process.

1. File Systems

MS-DOS and Windows uses a file system called File Allocation Table (FAT). FAT refers to the way files are organized. A table links one set of allocated chunks of space to another and reserves space for a given file. The FAT file system is simple, but it lacks security and "recoverability" features [Ref. 7]. FAT system was originally designed for floppy disks, generally 1 MB or smaller and it uses a table that is 16 bits wide to record the allocation status of a disk volume.

The OS/2 operating system uses a High Performance File System (HPFS) that greatly improves file access efficiency, and support for a larger media size, but it is also

limited to a maximum file size of 4 GB. HPFS uses 32 bits to enumerate its allocation unit.

a. NTFS

The New Technology File System (NTFS) makes up for the deficiencies of the FAT and HPFS. However, neither the FAT nor NTFS is entirely suitable for the Windows NT operating system. NTFS allows a file name up to 255 characters. It creates a short MS-DOS readable file name, thereby allowing MS-DOS programs to read NTFS files. NTFS allocates clusters and uses 64 bits to number them. A Windows NT Server can use one of the three file systems.

The advantages of available Windows NT File Systems: [Ref. 8]

Windows NT file System (NFTS):

- NTFS drive can be made secure meeting the C2 Security specification.
- NTFS allows the creation file names up to 255 characters. To maintain DOS compatibility, NT also creates a DOS compatible file names.
- NTFS maintains a log of activities and recovers files when the system crashes due to a power outage.

File Allocation Table (FAT):

- Allows access to files on a computer running MS-DOS or OS/2
- Is a widely used file system for PCs

High - Performance File System (HPFS):

- Has many features in common with NTFS
- Supports long file names
- Has a better error correction system than the FAT file system

Disadvantages of the available Windows NT File Systems: [Ref.8]

Windows NT File System:

- Computer running MS-DOS or OS/2 cannot access files on a NTFS partition on the same machine.

File Allocation Table:

- No C2 security features
- Cannot support large files

High - Performance File System:

- Has not been widely used
- No C2 security features

2. Domains and Workgroups

There are two different network models in the Windows NT environment - the Workgroups model and the domain model [Ref. 9]. Domain model for Windows NT Server is a collection of computers that share a common domain database and security policy. Each domain has a unique name and must have a primary domain controller (PDC) for centralized user account information. To avoid failure and ensure that the information will not be lost if the PDC crashes, the Windows NT Server propagates information to other computers in the domain, called Backup Domain Controllers (BDC).

The backup controllers provide read only access to data base and can satisfy validation requests and account query requests. A domain does not always need a BDC, but it is recommended at least one BDC be established in case the PDC is unavailable [Ref. 10].

The other server type in Windows NT Server domain is a server that functions as a file, print, and application server. This NT server machine does not have to be a domain controller, it can simply act as a server. A change of a machines status from server to domain controller cannot be changed without reinstalling NT Server.

The domain model provides a security administrator to maintain standard computer security policies across physical, divisional, and corporate boundaries.

The alternative to centralized domains is Workgroups security - in which each individual NT system, be it a workstation or server, must be maintained its own set of users accounts. Workgroups provide a way to group workstations/clients that do not belong to a domain. Administering a Workgroups is similar to administering a stand alone workstation. Each administrative task that an administrator executes affects only a single workstation. A group of NT workstations operating without any NT servers cannot be a domain because only NT servers can be operated as the Domain Controllers.

Windows NT Server offers fault tolerance, tape backup, Last Known Good Configuration, Emergency Repair Disk, and supports Uninterruptible power supply features to ensure that data is protected from disaster.

The fault tolerance features can be used alone or in combination to ensure that data is protected from potential media fault due to hardware malfunction and data corruption as a result of program error. These features are disk mirroring, disk duplexing, disk striping with parity, and Sector-sparing. Windows NT Server offers support for redundant array of inexpensive disks (RAID) levels 0 through 5. [Ref. 9, pp. 34-37]

The Windows NT Backup allows the user to backup and restore on a local tape drive. The backup program is located in the Administrative Tools group in the Program Manager. [Ref. 9, p.132] In the case SM LANs, the current system uses tape backup and it is done every quarter. The labs staff is planning to use disk mirroring or disk striping later, once the Windows NT integrated networking system has been established. [Ref. 15]

The Last Known Good Configuration feature allows the user to restore the system to the last working system configuration. The user usually must be able to recover at least to a previous known state in a system reboot. [Ref. 5, pp. 574-575]

Emergency Repair Disk allows the user to restore the system to its initial setup state. It must be the original disk created during installation on the original machine. Other Emergency Repair Disk will not be effective in restoring the system to its original configuration. [Ref. 5, pp. 576-577]

The Uninterruptible Power Supply (UPS) allows for the connection of a battery operated power supply to a computer to keep the system running during a power failure. The UPS service for Windows NT detects and warns users of power failures and manages a safe system shutdown when the backup power supply is about to fail. [Ref. 9, p. 61]

B. INSTALLATION OF WINDOWS NT SERVER

This subsection will not duplicate exactly the procedure for installation as is written. [Ref. 5, 11]. Installing Windows NT on a the Pentium 90 MHz connected to the token ring network will be started by inserting a boot diskette into the A: drive of the computer, then rebooting the computer, and following a menu of instructions. An "express" setup option provides the easiest route to installation, choosing the default settings and requiring little in the way of user input. It automatically configures the hardware settings and other components. It is recommended for the inexperienced user. The "custom" setup is designed for the experienced user only. In this case the installer can override default values or accept recommended settings to have more control over how the Windows NT Server is installed on the computer. The Windows NT Setup menu will guide the installer through the install process, using either floppies or a CD-ROM.

Install will carry the installer through the following steps:

1. Check the hardware to see whether the computer has SCSI devices. The Install program needs to know whether this is a CD-ROM installation or if the computer hard disk is controlled by an SCSI adapter.

2. Check the rest of the hardware for the machine type, presence of a mouse, keyboard, and display adapter type.

3. Windows NT install will ask where the installer would like the software installed. Disk information, including the number of partitions, will appear, with options to delete or create partitions. There are also options to reformat or convert partitions to NTFS. Care must be taken, because reformatting from one file system to another will destroy existing files. For the purpose of the SM labs, the installer should choose FAT option. It is the file system that DOS uses.

4. Setup will run the CHKDSK utility to make sure that the target disk is in good shape.

5. Setup copies the core Windows NT files from either CD-ROM or floppies to the hard disk.

6. At this point, the installer must remove the floppy A: drive and reboot the system.

7. The graphics mode of the install process will be invoked. The installer is prompted for the installer's name, company's name, and the product number. Windows NT is a network-ready operating system, so the computer needs a name to identify it on a network. A domain name will also be requested. Note that the computer name and domain name must be different.

8. A printer set-up is performed at this point. Windows NT will ask the installer to choose either a default printer or none. The PC to which the printer is connected needs only to have the printer driver files installed. The installer can choose none for the printer setup in this case.

9. Network set-up is the next step. Windows NT will try to find a network interface card (NIC). When it does, the network services will be installed to support the card. If the network card is not detected, the installer should find out whether the PC is compatible with one of the cards listed in the Windows NT compatibility list.

10. Windows NT install will ask the user to join a Workgroups or a domain. A Workgroups is a set of PCs that are grouped together for easy sharing of files and resources. A domain is similar to a Workgroups, but it includes security facilities that can limit access of certain users (i.e., strategic database).

11. The process will prompt the installer to enter and verify a password as a user and as an Administrator. The responsibility as an Administrator is to manage resources and users for all computers. The Administrator has more privileges than normal users on all computers in the labs.

12. The next step is to write an Emergency Repair Disk (insert in the A: drive). This disk is used in the event that the system is not bootable--which could happen if the Windows NT system files have been inadvertently corrupted. Each Emergency Repair Disk is useful only for that particular computer installation. It cannot be used on a different computer.

13. Setup asks the installer to tell Windows NT the time zone in which the installer lives.

After completing successfully all the installing steps, the user is ready to run Windows NT. The Windows NT will present a title screen with a notice that the user must press CTL+ALT+DELETE to log on to the system.

Like UNIX, the user should go through a power-down software sequence before turning off the power or rebooting the system. This process needs to write the unsaved data to the disk or to ensure there is no application still running on the system. Both the log out and shutdown procedures are initiated from under the Program Manager's File menu.

C. TESTING

In addition to a Windows NT Server 3.51 the Systems Management integrated token ring network has servers and clients that are configured for Windows For Workgroups Version 3.11. The networking features of WFWG make it easy for the client to communicate and share information with other clients. It is also convenient for any clients to access the applications installed on the servers.

Windows NT Server 3.51 has a built-in capability for many kinds of testing using Performance Monitor for the detection of many foreseeable problems. The Performance Monitor is used to examine an array of parameters that covers a wide spectrum of the systems functionality and hardware components such as the processor, memory subsystem, the operating system components, thread and processes resources. Because the current configuration of the Windows NT Server 3.51 only has a few applications installed, the Performance Monitor cannot be used to monitor resources throughout the network.

For the purpose of testing the server in this research, the author is using WFWG servers PN3, PN6, and the Windows NT Server 3.51 PN9. Client testing was done using TN10 in room I-158 to run MS-DOS-based applications under Windows for a prototype test [Ref. 10].

The purpose of this experiment is to prove that the Windows NT Server 3.51 PN9 can logically be connected to other servers and clients on the network. This experiment

uses MS-DOS-based application by loading SMERFS into PN9 from PN3 that reside on WFWG Server PN3 or PN6 that can be copied to Windows NT Server 3.51 PN9. The SMERFS was used in this experiment because it is not a big program, so it does not take a long time to be accessed. This experiment should also demonstrate how to use MS-DOS-based applications with Windows NT Server 3.51.

First, a sub-directory should be created in PN9's physical drive to hold the application under test. This is accomplished using the File Manager menu. With this window still open, a second window is opened. This second window is used to display the directories of the virtual drive in either PN3 or PN6 where the desired MS-DOS-based application (i.e., SMERFS) is stored. To copy the desired application over to PN9, the appropriate files are clicked and dragged from the virtual drive to PN9's physical drive. This initiates the copying sequence. The user is presented with a window requesting an acknowledgment and permission to proceed with the copy process. Once the copy has been transferred, the installation is complete. In order to access the virtual drive on PN3 or PN6, the drive must be designed as a shared resource using networking sharing functions from its respective client computer. In addition, PN9 must be connected to virtual drive using network connect functions.

In the client computer TN 10 (i.e., loading SMERFS into TN10) there are 3 steps that must be accomplished:

- Network is connected to Windows NT Server 3.51 PN9 for access to the drive. PN9's drive must be shared; this provides access to the file, and establishes the logical connect for the drive.
- Establish an icon for Windows; first identify the path to the file using Properties menu. Select an icon for the MS-DOS-based application from the available Program Manager icons. Select File-New, then create a new program item icon.
- Update the Program Information File (PIF) using the PIF editor. Though this step is partially redundant to data entered in the Properties menu, it is necessary to update the PIF for this specific MS-DOS-based application. The PIF governs DOS access to the file in the Server and allows the setting of

specific parameters for memory access under the Advanced menu. The PIF must be set in the client TN10 to point to the file in PN9.

To exit an MS-DOS based application, switch to the MS-DOS-based application window, then choose the appropriate command from within the MS-DOS application to quit. To terminate an MS-DOS-based application from Windows, switch the MS-DOS-based application from full screen to a window, then, from the control menu, choose Settings then click terminate.

D. FUTURE APPLICATION INSTALLATION

The next step in the upgrade after installing the Windows NT 3.51 on the Pentium Server PN9 is to install the Windows NT Server with any applications the SM Lab supports and to convert PN3 and PN6 to Windows NT Servers 3.51. This gives the servers more capability in supporting increasing users demand.

In the long run using NTFS support should also be considered. If implemented on all the three servers, the network would benefit from NTFS client server file management.

E. CHAPTER SUMMARY

The Windows NT Server 3.51 system installation is highly automated, but still requires talented and knowledgeable personnel to install. Because of its size and complexity there are potential pitfalls in the issues of hardware compatibility - typically conflicting interrupts or addresses.

The physical connection in this research was done by the installation of cabling between computer PN9 and the MAU of the token ring network in I-158. The logical connection has been partially tested successfully by running DOSs application on TN10.

IV. SETTING UP CLIENT TO ACCESS NT SERVER - A PROTOTYPE

Each part of the integrated network of the SM computer laboratories is configured for its expected use. The laboratory in I-250 was set up for instruction in computer literacy and decision support. The laboratory in I-224 was set up to provide instruction in LAN technologies. The laboratory in I-158 was intended for research of software metrics, and also as a test bed for new applications and configurations [Ref. 10]. All the three laboratories are using WFWG as a network operating system and can already run many applications for the client from one of the three servers (including Windows NT Server 3.51 although it has few application installed on it). The Windows 95 operating system also has been installed on six computers in I-158. All the facilities have been set up and configured by the Lab Staff.

Chapter III, explained how to access the Windows NT Server from a client running an application under WFWG. Now in this chapter, the thesis research will be directed to using several clients running WFWG in I-250, to access Windows NT Server. This will demonstrate the concept of incrementally testing of the physical and logical connections to ensure the network connections is working properly [Ref. 12]. An additional area of research is the test conducted with the implementation of running applications under Windows 95 in I-158.

A. INCREMENTAL INSTALLATION AND TESTING PROCEDURES

This subsection provides concepts of incremental installation, and testing the performance of the server. The starting point of this phase is to assess each application against users requirement. A decision is made as to what application needs (i.e., applications software) to be installed. The following step is to make preparation for the installation of the application.

Following this preparation, the installation process itself can be accomplished through opening Program Manager Window in PN9 Windows NT Server, then from the File Menu choose Run with the mouse or press "ALT, F, R" on the keyboard. In the File

Name text box, type "a:\ install" and choose OK with the mouse or enter on the keyboard. This installation process will create a directory, and then copy the files from the application software disk or CD ROM to the PN9 Windows NT Server. This technique of configuring Windows application also places a small group of user files on the user local drive (i.e., .INI files, .GRP files, .PIF files). These files are needed to support the users and they must be in the search path from the user computer, either in the Windows Directory (usually \WINDOWS) or in the application directory on the Windows NT file server in order to run the windows application from the user/client computer. The Properties Menu must be verified to ensure the paths are correctly mapped to the physical and virtual drives when application initialization files are executed.

1. Benefits of Incremental Installation

The installation process will follow the incremental installation concept as the installation plan for building the SM integrated token ring network is finalized [Ref. 1, p.15]. The incremental installation approach is started with the wiring and physical connections, their installation and testing. The next step in the incremental installation is the testing of servers and the user computers. Installing the network in discrete stages provides the network administrators with a way to quickly pinpoint when a problem appears. For example, if incremental installation and testing procedures are followed and a problem in the network occurs, the cause of the problem is most probably associated with whatever steps were performed when the problem surfaced. Thus, incremental installation will help to isolate the cause of the problem and pinpoint where trouble shooting should begin. In addition to incremental testing, multi-user testing also can be conducted. The performance test will be discussed in more details later in this chapter.

B. RUNNING APPLICATIONS UNDER WINDOWS FOR WORKGROUPS

As mentioned previously, the SM integrated token ring network has been established with clients and servers in a peer-to-peer network, using the WFWG network operating system with access to a dedicated server. The purpose of the following research is to test whether the Windows NT Server PN9 can be logically connected and accessed from any

clients on the integrated token ring network. The test procedure that was used "in the small" version in I-158 (i.e., Chapter II) that can be implemented into a larger working environment like the SM LANs. The test was conducted using all 9 Pentium computers in I-250 N10-15 and N17-19 as the sample test network to represent the entire integrated token ring network. It was conducted between PN3 Server, PN9 Windows NT Server and User N13 user computer. Since PN9 Windows NT Server has no application on it, the research for the client server performance test will be conducted using the application on PN3 that are mapped to PN9 (i.e., SMERFS).

From the File Manager on N13:

- Connect to PN3 server under Public directory (i.e., E:*.*\\PN3\PUBLIC), then click on SMERFS directory.
- Open another Window, then connect to PN9 Windows NT Server on SMERFS directory (i.e., F:*.*\\PN9\SMERFS). There are many programs/files for SMERF but without any .EXE file. It means the SMERFS cannot be run/execute.
- From virtual drive E, copy the SMERFS directory to virtual drive F under SMERFS directory. Now, the virtual drive F has SMERFS directory with program .EXE on it. (i.e., SMERFS. EXE). Run SMERFS program by double clicking on SMERFS5.EXE files or
- Continue to create program icon for this MS-DOS based application on main program as it has been done on test procedure in lab I-158.
- SMERFS icon is available on N13.
- Repeat the procedure for the other eight Pentium computers.

Incrementally test for using computers running under WFWG to access an application (i.e., SMERFS on Window NT Server 3.51 PN9).

The timing test was performed on different user computers and with a group of machines simultaneously. The access time was tested beginning with booting-up the machine, and loading WFWG as well as loading the applications. The Performance test results are presented on the table as follows:

- The first column is number of user computers used during testing process.
- The second column is access time for booting-up the computer to C:>.
- The third column is access time for loading WFWG.
- The fourth column is access time for Word Perfect for Windows Version 6.1 (i.e., WPWIN v 6.1) to PN3 Server.
- The fifth column is access time for Word Perfect for DOS version 6.0 (i.e., WPDOS v.6.1) from PN6 Server.
- The sixth column is access time for SMERFS-DOS base application to PN9 Windows NT Server.
- The seventh column is total access time associated with their respective row.

Load Access Times in Seconds						
Number of User Computers	**Time to C:>**	**WFWG**	**PN3 WPWIN v 6.1**	**PN6 WPDOS v 6.0**	**PN9 SMERFS (DOS)**	**Total Time (second)**
1	37	26				63
1	37	26	14			77
1	37	26		9		72
1	37	26			1.25	64.25
6	37	27				64
6	37	27	33			97
6	37	27		26		90
6	37	27			1.31	65.31
9	39	27				66
9	39	27	49			115
9	39	27		32		98
9	39	27			1.40	67.4

Table 1. Access Times for 1, 6 and 9 Pentium 90 MHz

C. RUNNING APPLICATION UNDER WINDOWS 95

Windows NT Server is the right server for Windows 95-based clients for the following reasons: [Ref. 14]

- Windows 95 and NT Server were designed to work together. This combination results in integration.
- One server meets all of networking needs.

Windows 95 is advertised to be compatible with previous versions of Windows and DOS. It provides the necessary software for peer-to-peer networking and for the client side of client-server networking.

Concerning with the SM LANs, the following research was conducted in I-158 to test whether the Windows NT Server PN9 can be logically connected and accessed from any clients running application under Windows 95. The test was conducted between PN3 Server, PN9 Windows NT Server and TN5 User computer as follows: [Ref. 10]

1. Setup SMERFS on Windows NT Server PN9, Feasible to PN3 Server.

- Find SMERFS on PN3. The SMERFS reside on PN3's public directory.
- Copy the SMERFS at PN3 Server (i.e., on a network drive G:\\PN3\PUBLIC currently) to PN9 server under APSS directory (i.e., C:\APSS) by dragging and dropping its icon between both directories.
- Enable sharing of the hard drive of the PN9 server (i.e., C:\APSS\SMERFS) to the network and check the access privileges.

2. Access the SMERFS on Windows NT Server PN9 from TN5 User computer.

- First, use the tools from Window Explorer to map the network drive for SMERFS sub directory, (PN9:\\APPS\SMERFS), to the virtual drive. Then, start Windows Explorer and find smerfs5.exe in "content of" SMERFS on PN9.

- Go into the SMERFS directory and highlight the smerfs5.exe to check the appropriate properties. Under general properties, deselect the read only status so SMERFS will execute properly. This program properties indicates the path/command line and working directory.

- Double click the file and it will be executed. An MS-DOS Window is open (i.e., contains the executed program) and the program is run.

- Install SMERFS on the PN5 client by holding down the CTRL-Shift key and dragging the executable icon or shortcut to the desktop. This shortcut is represented by an icon that resides on the client desktop.

- Test the operation of SMERFS by using module1. as an input file. With this file, the operation of SMERFS appeared to operate successfully.

D. FUTURE UPGRADES

Although the WFWG network operating system was installed less than four months ago, the SM integrated token ring network has met the need of users in SM Department. To keep up with the new technologies, the lab staff intends to complete the installation of new software (i.e., Windows 95) and hardware (i.e., Pentium 90 MHz). The Windows 95 operating system has better features than WFWG in the areas of: [Ref. 19, pp. 2-16]

- A Better User Interface

- Easier to Setup, Add, and Remove Hardware

- Greater System Reliability and Performance
- Centralized Security .

Meeting the needs of the Information Technology Management (ITM) curricula to have the best current networking technology for the ITM students, the Lab I-224 will be upgraded to Client Windows 95 from Client WFWG .

The combination of Windows NT Server and Windows 95 should provide better integrated enterprise-wide networking system. This network would support the future ITM graduate students with applicable knowledge because the DoD\Navy information technology is currently moving to Windows NT and Windows 95 networking environment.

When the NT network environment is implemented, consideration should be given to upgrading the SM LANs simultaneously to a Single Domain Model. The model is applicable to an organization with relatively users who do not need to be split their utilization by application and location. This would centralize the management of user accounts and improve the system security [Ref. 9, p. 344].

E. CHAPTER SUMMARY

This chapter described the implementation of incremental installation and testing procedures. The logical client-server connection has been partially implemented and tested successfully using a client running WFWG and a client running Windows 95. The following chapter presents a review of the research questions, conclusions and recommendation.

V. CONCLUSIONS AND RECOMMENDATIONS

A. REVIEW OF RESEARCH QUESTIONS

1. Research Question 1

What is the current networking system of the SM computer laboratories?

It is an integrated token ring local area network with a physical/wiring and topology of a star and logical ring and speed of 16Mbps. The SM laboratories integrated the token ring in I-224 (referred to as 4TR), I-250 (referred to as OTR), and I-158 (referred to as 8TR) into a single networking system.

This integrated network has three dedicated servers; two servers were installed with many applications (i.e., MS-DOS and Windows applications) running under Windows for Workgroups. The other one, Windows NT Server 3.51, has only a few applications installed. However new applications are being installed on the Windows NT Server 3.51 and the existing applications that are now installed on the Windows for Workgroups servers will be transferred to multiple Windows NT Servers. These servers provide service for more than fifty user computers throughout the LANs. There are also five dedicated printers with one printer in I-250, two printers in I-224 and two printers in I-158. Since the network is using Windows for Workgroups as the network operating system (i.e., peer-to-peer networking), user computers can act as both server and client.

2. Research Question 2

What is the Windows NT Server 3.51? Windows NT Server 3.51 is a 32 bit operating system that supports 16 bit DOS and Windows applications. Windows NT 3.51 includes built-in networking capabilities, a C-2 security rating and the ability to run on many platforms. The Windows NT Server operating system has true multitasking ability and enhanced graphics and a Windows interface. One of the most important features of Windows NT is its ability to run on non-Intel processors. In addition to Intel's family of 386, 486 and Pentium processors, Windows NT Server supports the high-performance RISC (Reduced Instruction Set Computer) processors.

Windows NT Server 3.51 requires at least a 25 MHz 386 processor and 12 MB RAM, although this is an absolute minimum and in reality is an impractical small memory for a server. It also needs 90 MB of disk space for the complete operating system, including networking, OS/2 and POSIX support. For many users, this is a huge disk space requirement. For users who will develop or simply run applications, a 100-150 MB of hard disk space will be required just to get started. However, the minimum disk size now available on new machines is nearer 500 MB then the 200 MB disks of few years ago.

As was stated in the future upgrades section in Chapter III and Chapter IV, when the lab staff has acquired enough experience with Windows NT Servers 3.51 to serve users using centralize File Allocation Table (FAT), the server can be redeveloped to use the NT File System (NTFS). The NTFS is more reliable and secure than the existing file system and it has an important additional feature: it can recover from an operating system or hardware failure. NTFS has the ability to reconstruct itself so that the volume (partition) remains accessible and consistent and the directory structure is not corrupted [Ref. 7, p. 2]. This will work even better if the network environment uses a single domain model, since the model will centralize the management of user accounts and improve system security.

3. Research Question 3

How would the installation of the Windows NT 3.51 help the SM labs?

This is a follow up to the answer for research question 1. The installation of any applications needed to support the users of the network on the Windows NT Server 3.51 should be performed (i.e., this has been discussed in Chapter IV Section A). The Windows NT Server 3.51 will complement the operation of the other two servers which run applications under WFWG. The SM LANs would then work fully as a Windows NT Workgroups using the three available servers. This will improve the current performance of the LANs to provide application support for users. It would make it possible to operate the Windows NT Server 3.51 with secure application programs and a secure data

base. Since the Windows NT Server 3.51 has better security features than WFWG, the lab staff could control sensitive information by storing it on the Windows NT Server 3.51. This would provide the following advantages:

- provide protection and log on procedures that users must perform to gain access to the system.
- assign resource privileges to individual users or to user groups.
- maintain a full user-name and password list on the Windows NT 3.51 Server.

The lab staff also can check CPU utilization using the performance monitor. The User Manager application also lets the lab staff add, change, and delete user, as well as change permission quickly. A new backup utility can also backup system disk resources to tape and restore files when needed.

By accomplishing the above tasks, the SM LANs servers can be centralized. The Windows NT 3.51 Server maintains a full user-name and password list (i.e., centralization), while the other two servers still have their own style of resource sharing (i.e., peer-to-peer), where any users can access a shared resource. Mixing the two approaches would enable guest accounts on Windows NT 3.51 Server for a non secure access, and maintain the user accounts for users who require access to secure resources. This could become a major administrative burden later when there is a significant increase of user accounts on the Windows NT server. At that time it will be time to upgrade Workgroups model to a Windows NT domain model [Ref. 5, pp. 407-408].

B. RECOMMENDATIONS

Since the ability of the Windows NT Server 3.51 to provide application software for clients on the integrated token ring network has been partially tested successfully in Lab I-158, applications should be implemented incrementally on the network.

- The lab staff should install applications on the Windows NT 3.51 Server and additional Windows NT Servers. Before making the applications available for

the users on the network, the lab staff should conduct testing to verify for correct system operation, as follows:

- connect to and browse the network.
- open, run, and close applications on both servers and on the client computers under the current WFWG network operating system and later on Windows 95 clients.

Windows 95 should be installed on the client computers. The lab staff has established several clients running application under Windows 95 in I-158, Windows 95 could be implemented incrementally in I-224 first, then in I-250 later. The combination of Windows NT Server and Windows 95 clients will provide greater integrated networking system compared to using Windows for Workgroups client. Windows 95 provides software for peer-to-peer networking and for the client side of client server networking. This new technology will give additional value for ITM students, since they often use the Networks Lab I-224 .

- Future upgrades should be considered to use the features that have been built into Windows NT Server 3.51. Instead of using the current Workgroups architecture, the Windows NT Server 3.51 can be expanded to support domain architecture. This administrative domain that makes up the network is characterized by the existence of a single Primary Domain Controller (PDC), which must be on a Windows NT 3.51 Server. All users log on to the PDC, and the PDC stores account information for all computers in the domain. This will greatly simplify the lab staff responsibility (i.e., due to limited personnel for the labs), because it is possible to manage those user accounts from a central location on the NT server.

LIST OF REFERENCES

1. Mc Gillvray, Patrick G., *Integration of SM Dept. OTR, 4TR and 8TR Token Ring LAN*, Master's Thesis, Naval Postgraduate School Monterey California, September 1995.

2. Linberg, J. P. Kelley, Novell's *Netware 3.12 Administrator Handbook*, Berkeley California: Sybex Inc., 1995.

3. Microsoft, *Resource Guide*, Windows NT Resource Kit, Vol. 1, Redmond, Washington: Microsoft Press, 1995.

4. Microsoft, *Networking Guide,* Windows NT Resource Kit, Vol. 2, Redmond, Washington: Microsoft Press, 1995.

5. Minasi, Mark, Christa Anderson and Elizabeth Creegan, *Mastering Windows NT Server 3.5*, Berkeley California: Sybex Inc., 1995.

6. Schneidewind, Norman, Personal interview, Naval Postgraduate School, November 1995.

7. Custer, Helen, *Inside Window NT File System*, Redmond, Washington: Microsoft Press, 1994.

8. Microsoft, *Version 3.51 Update*, Windows NT Resource Kit, Vol. 5, Redmond, Washington: Microsoft Press, 1995.

9. Ruley, John D., *Networking Windows NT 3.51*, New York: John Wiley and Sons, 1995.

10. Schneidewind, Norman, IS-3503 Class notes, Naval Postgraduate School, 1996.

11. Microsoft, *Windows NT Server Installation Guide*, *Version 3.5*, Redmond, Washington: Microsoft Press, 1994.

12. Schneidewind, Norman, Personal interview, Naval Postgraduate School, January 23, 1996.

13. Feibel, Werner, *Complete Encyclopedia of Networking*, Berkeley California: Sybex Inc., 1995.

14. Microsoft, "Windows NT Server 3.51," Internet (http:/www.microsoft.com) 1995.

15. Sahlman, Leon R, Personal interview, Naval Postgraduate School, February 15, 1996.

16. Microsoft, *Windows 95 Resource Kit*, Redmond, Washington: Microsoft Press, 1995.

INITIAL DISTRIBUTION LIST

		No. Copies
1.	Defense Technical Information Center 8725 John J. Kingman Rd., STE 0944 Ft. Belvoir, VA 22060-6218	2
2.	Dudley Knox Library Naval Postgraduate School 411 Dyer Rd. Monterey, California 93943-5101	2
3.	Professor Norman F. Schneidewind Department Of System Management, Code SM/Ss Naval Postgraduate School Monterey, Ca 93943-5103	1
4.	Professor Rex A. Buddenberg Department Of System Management, Code SM/Bu Naval Postgraduate School Monterey, Ca 93943-5103	1
5.	DEOPS KASAL Mabesal, Cilangkap, Jakarta-Timur JAKARTA INDONESIA	1
6.	DEPERS KASAL Mabesal, Cilangkap, Jakarta-Timur JAKARTA INDONESIA	2
7.	DELOG KASAL Mabesal, Cilangkap, Jakarta-Timur JAKARTA INDONESIA	1

8.	ASRENA KASAL Mabesal, Cilangkap, Jakarta-Timur JAKARTA INDONESIA	1
9.	GUBERNUR AKADEMI ANGKATAN LAUT Morokrembangan SURABAYA - 60165 INDONESIA	1
10	Ltk.Laut (E) Ir. Mochamad Arum Jln. Tanjung Priok 30A SURABAYA-60165 INDONESIA	2